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Federal Communications Commission  
Office of the Secretary

Before the  
Federal Communications Commission  
Washington, D.C. 20554

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In the Matter of )

Advanced Television Systems )  
and Their Impact on the )  
Existing Television Broadcast Service )

MM Docket ✓  
No. 87-268  
RM-5811

Review of Technical and )  
Operational Requirements )  
Part 73-E Television )  
Broadcast Stations )

Reevaluation of the UHF Television )  
Channel and Distance Separation )  
Requirements of Part 73 of the )  
Commission's Rules )

REPLY COMMENTS OF NHK - THE JAPAN BROADCASTING CORPORATION

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## SUMMARY

NHK is a principal developer of a family of advanced television systems called the MUSE Family Systems. The NHK MUSE Family Systems have been designed to meet all of the major concerns raised by the NOI, the FCC, the U.S. Congress, and other commentators in this proceeding.

The NHK system provides the means for a smooth transition from the current NTSC standard to true HDTV quality through use of its NTSC-compatible member components. Consumer sales of all HDTV receivers as well as inexpensive converters will allow audiences to watch both NTSC and HDTV signals. Broadcasters may enhance the quality of their signals by using a MUSE transmission system compatible with existing NTSC equipment.

The introduction of MUSE technology, along with a planned orderly transition, can resolve favorably issues concerning quality, compatibility, cost and spectrum allocation. There is wide acceptance of the proposition that superior quality is the objective, and that the MUSE HDTV signal delivers that superior picture quality. Compatibility issues are addressed through the NTSC MUSE-6 format which is a transitional system designed for NTSC compatibility in order to ease the transition to full MUSE HDTV. Adoption of this two-phase system will lower the overall

costs to consumers and to broadcasters because equipment changes for both groups can be phased in gradually. Early adoption of this transitional system will also allow for the resolution of outstanding spectrum issues.

NHK has spent 17 years developing its HDTV system. The hardware will be available quickly, and with proper advance planning the broadcasting industry and the FCC can make the transition smoothly and with minimal cost. It is NHK's intention and desire to maintain a cooperative relationship that will be mutually beneficial to both the U.S. and Japan.

However, time is short. Unless the FCC moves quickly, other media, such as cable, DBS, and VCRs, will establish an advantage by developing the capability to distribute HDTV programming. Adoption of MUSE would diminish any time advantages of broadcasting's competitors.

NHK recommends that testing criteria be decided upon quickly so that both system testing and spectrum reallocation testing can begin and be completed within one year. Advanced planning is absolutely necessary for a smooth transition to HDTV because too much delay will relegate broadcasters to second class status as HDTV becomes, through other media, the quality to which Americans will become quickly accustomed.

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**REPLY COMMENTS OF  
NHK - THE JAPAN BROADCASTING COMPANY**

**I. INTRODUCTION**

Nippon Hoso Kyokai, "NHK" (The Japan Broadcasting Corporation) submits these Reply Comments to the Federal Communications Commission (FCC or Commission) in the above-captioned proceeding.\*

NHK is a principal developer of a family of advanced television systems called the MUSE Family Systems. MUSE, an abbreviation for Multiple Sub-Nyquist Sampling Encoding, is a bandwidth compression format which compresses a video signal from 22 MHz to 8.1 MHz, thus allowing satellite transmission of high definition television (HDTV). Although MUSE HDTV cannot be received on existing conventional television sets without a converter, in its Comments filed on November 18, 1987, NHK introduced other member components in the MUSE Family Systems which employ the MUSE technology and can be received over conventional (NTSC) television receivers. NHK suggested that an NTSC-compatible component of the MUSE family be used as a transition to true HDTV in the United States.

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\* Notice of Inquiry in MM Docket No. 87-268, FCC 87-246, adopted July 16, 1987, 2 FCC Rcd 5125 (1987), 52 Fed. Reg. 34259 (September 10, 1987).

## II. THE MUSE FAMILY SYSTEMS MEET THE CONCERNS VOICED BY OTHER COMMENTERS

NHK seeks to cooperate to the greatest extent possible in helping to bring a new age of television of the highest technical quality to the American public. The NHK MUSE Family Systems have been designed to meet all of the major concerns raised by other commentators in the NOI, FCC, and the U.S. Congress.

The NHK system provides the means for a smooth transition from the current NTSC standard to true HDTV quality through use of its NTSC-compatible member components. Consumer sales of all HDTV receivers and/or inexpensive converters will allow audiences to watch both NTSC and HDTV signals. Broadcasters may enhance the quality of their signals by using a MUSE transmission system compatible with existing NTSC equipment. The introduction of MUSE technology, along with a planned orderly transition, can resolve favorably issues concerning compatibility, spectrum allocation and cost.

A. THERE IS WIDE ACCEPTANCE OF THE PROPOSITION THAT  
SUPERIOR QUALITY IS THE OBJECTIVE

As shown repeatedly throughout the Comments which were filed by the 70 parties in this proceeding, quality is a paramount concern. As NHK also stated previously, "the quality of pictures available to the consumer is the very reason for this Inquiry." Statements from the Congress, the FCC, and other Commenters acknowledge consumer demand for such improvements in quality.

NCTA: "Maintaining compatibility with NTSC is not essential if it means that true high definition television will be unavailable to the American public." p. 10.

INTV: "It is imperative...to assure that local television broadcast stations have the means and a fair opportunity to provide high-quality, fully competitive HDTV service to the general public in their local communities." p. 2.

Matsushita: "We recommend that the Commission...choose a delivery standard whose performance will be as close to HDTV as possible." p. ii.

Japan Satellite Broadcasting Inc.: "It is essential to select the system which is regarded as the best from a technical or economical point of view. In the area of HDTV . . . the Muse developed by NHK is being regarded as one of the most practical and well-established systems." p. 3.

Pulitzer Broadcasting Company: "The quality of ATV must approach 35 mm film . . . . Artifacts must disappear." p. 4.



Cox Enterprises Inc.: "If the technical quality of [a] domestic NTSC-compatible, ATV or HDTV system is not comparable to MUSE or other available technology, it will not succeed. The first HDTV system inevitably becomes the model against which the technical quality of subsequent HDTV and other ATV systems are judged." p. 11.

American Family Broadcast Group, Inc.: "American broadcasters must be able to compete with MUSE in terms of video signal quality". p. 4.

National Association of Broadcasters: "Should the television broadcast service not be able to employ HDTV as these other media will, the results would be catastrophic for the broadcast industry." p. 4, 16.

North American Phillips Corporation: "ATV can and should be introduced in an evolutionary manner . . . the ultimate goal of the evolutionary process should be a high definition television system." p. v.

CBS Inc.: "CBS believes that one preeminent criterion for the consideration of ATV systems is the need for technical quality that will be competitive with that expected to be achieved by non-broadcast media without spectrum constraints." pp. 21, 22.

These statements speak strongly in support of picture quality as the top priority in this proceeding. Several of the commenters acknowledged that MUSE HDTV represents the highest quality system and "the model against which the technical quality of subsequent HDTV and other ATV systems are judged."\* Cox, p. 11.

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\* Even the Sarnoff Research Center acknowledges that an NTSC compatible system which it advocates would not be "full HDTV quality." Sarnoff p. 14.

Many of the commenters acknowledged the certain eventuality of high definition television in the U.S. As shown above, many also acknowledge that NHK's MUSE HDTV offers the highest quality system. The joint US-Japan demonstration of MUSE-HDTV to the U.S. Congress in 1987 gave notice that HDTV has entered an era of practical application. Only the NHK MUSE system has been tested under actual broadcast conditions and only the MUSE system is close to production of consumer equipment within the next three years.

The MUSE HDTV signal allows the transmission of five times more data than a conventional NTSC signal, thus creating picture quality on a receiver that is equivalent to 35 mm color film, rendering extraordinary realism and a high level psychovisual effect. With quality and MUSE used as synonymous terms, the question then becomes, "Is there any reason not to adopt the MUSE HDTV and the other components of the MUSE Family Systems as the standard for the new age of American television?" The answer is, "No," especially after consideration of the following factors.

## B. THE MUSE FAMILY SYSTEMS OFFER COMPATIBILITY WITH NTSC

In the United States it appears that there are strong views favoring a gradual progression to HDTV, placing considerable importance on a transitional ATV system that is compatible with the current format, rather than on the improvement of picture quality in the conventional system. As explained in some detail in NHK's Comments, components of the MUSE Family Systems (see Figure 1) provide compatibility with NTSC in several respects.

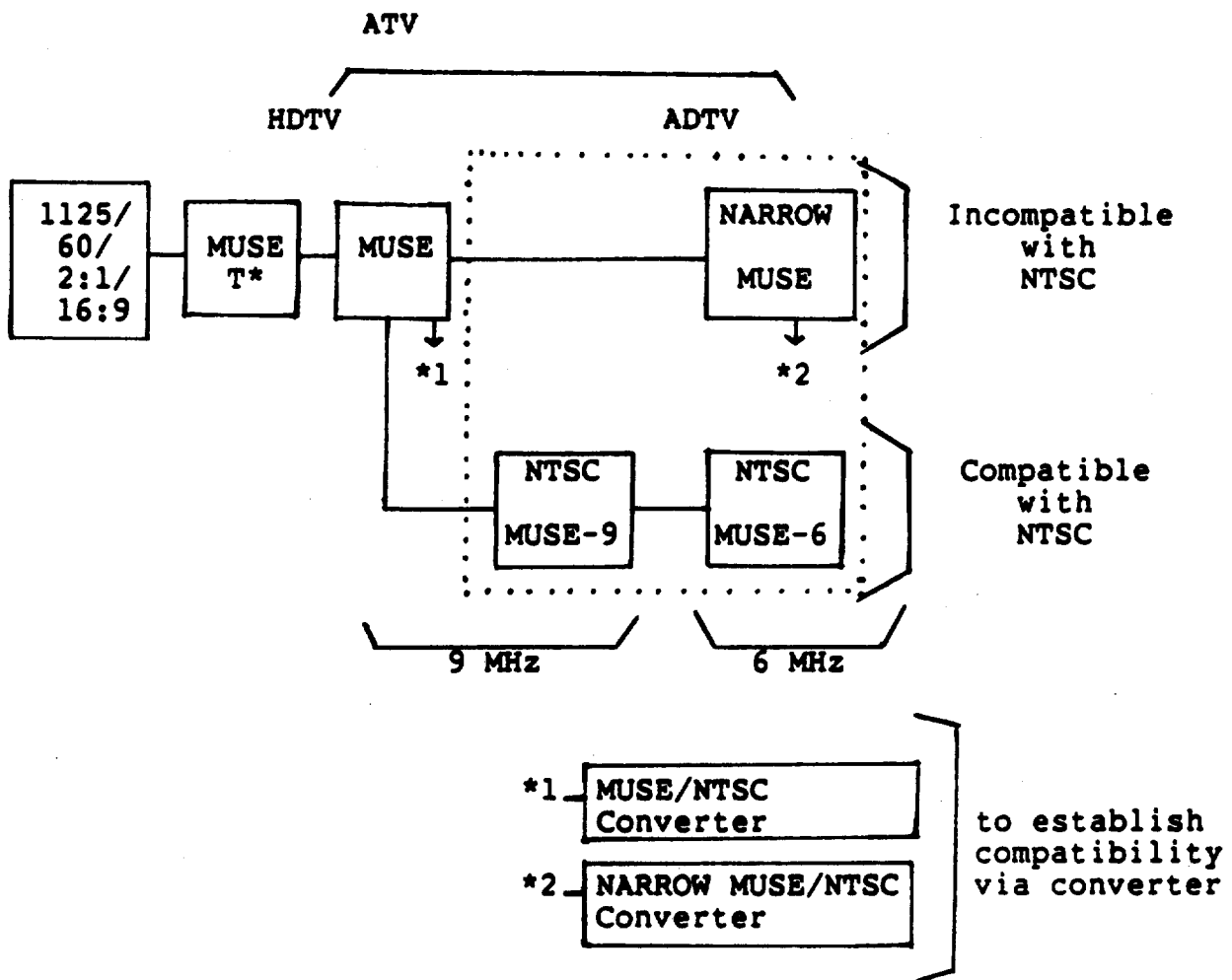
While MUSE HDTV and the NTSC formats by themselves are not compatible, the MUSE HDTV receiver will receive signals in both formats, and existing NTSC receivers could accept MUSE transmissions by adding a small low-cost converter. The converter, costing less than \$50,\* offers the most practical means of attaining compatibility for the consumer.

Another component of the MUSE Family, for broadcasters seeking to improve transmission quality within existing channel allocations, is an NTSC-compatible advanced definition television format (ADTV)

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\* The cost of each converter would, of course, be less if the number of converters produced is high.

Fig. 1 MUSE Family Concept



\* MUSE-T Transmission system for program source

called NTSC MUSE-6, which can be received over NTSC sets without a converter.\* The NTSC MUSE-6 format has the greatest compatibility with the conventional NTSC system. Since it uses a 6 MHz channel, compatibility with conventional receivers is maintained.

Picture quality of the NTSC MUSE-6 format is only improved by a single grade when compared to the current NTSC format.\*\* See Figure 2. The system's limitations on improved picture quality (as compared to HDTV) in order to maintain its compatibility with the NTSC standard is a drawback. Its advantage, of course, is that, as part of the MUSE family, it provides the quickest and easiest way for a television station to make a

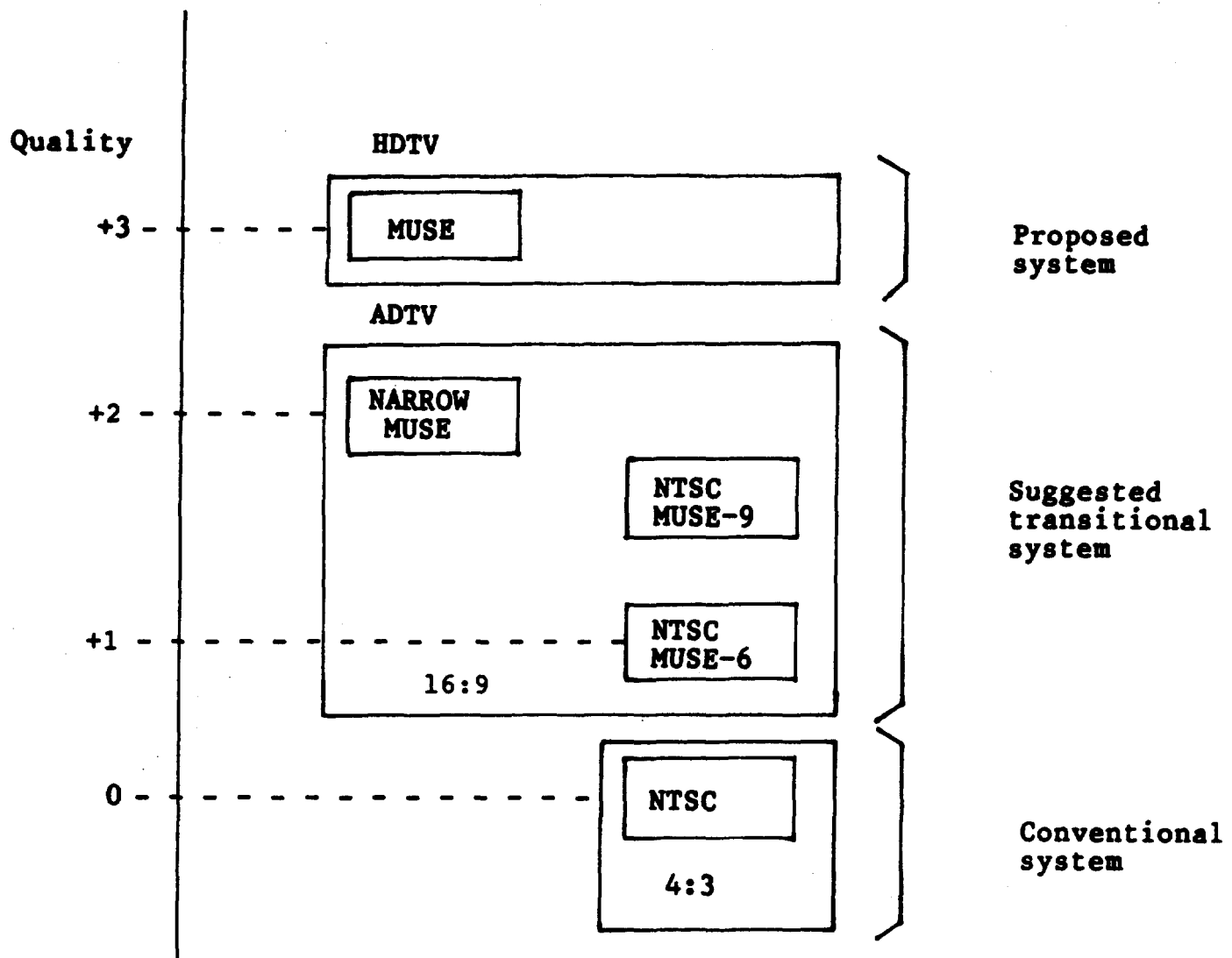
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\* The MUSE Family has two NTSC-compatible advanced definition television formats (ADTV) called NTSC MUSE-6 and NTSC MUSE-9. Both of these systems can be received over NTSC sets without a converter. NTSC MUSE-9 requires 9 MHz bandwidth and thus would not meet the concerns of most commenters for a 6 MHz NTSC-compatible system. A third ADTV format, Narrow MUSE, requires 6 MHz but can only be received over an NTSC set with the aid of a converter.

\*\* Seven Grade Comparison Scale authorized by CCIR:

+3	Much better
+2	Better
+1	Slightly better
0	The same
-1	Slightly worse
-2	Worse
-3	Much worse

**Fig. 2 Comparison of Picture Quality  
between ATV and NTSC system**



gradual transition to full MUSE HDTV through purchase of production and transmission equipment that will be cross compatible with NTSC, NTSC MUSE-6 and MUSE HDTV. NTSC MUSE-6 can be employed while there are still restrictions on transmission bandwidth. After resolution of spectrum allocation questions, only the encoder, transmitter and transmission lines will have to be changed as the switcher from NTSC MUSE-6 to full HDTV takes place. This will cut unnecessary investment outlays for broadcast studio facilities and prevent multiple receiver costs for consumers.

Thus, the NHK MUSE Family provides a two-step transitional system that answers the concerns of many of the commenters and does not leave open-ended questions to be answered regarding a transition to HDTV as do other system proposals. In fact, the MUSE Family Systems meet the desires expressed by GE and Sarnoff for a two-phase system that is NTSC-compatible, has improved aspect ratio and improved picture resolution. Sarnoff, p. 32. GE, p. 3-4. These MUSE Family ADTV formats do not produce true high definition pictures but can quickly serve as a transition to HDTV, while spectrum changes, among other issues, are being resolved.

While NHK has advanced proposals on NTSC MUSE-6 and other systems which are compatible with the conventional television format in response to the requests of the NAB, MST and other broadcast organizations, it must be remembered that all such systems are only meant to be transitional. The full MUSE HDTV system can be used immediately in non-broadcast media such as cable television, communications satellite distribution, and VCRs. While a transitional system like NTSC MUSE-6 can be expected to have a relatively long and useful life, there is no question that it will not be able to compete effectively over the long term with full MUSE HDTV.

It must be recognized, however, that pursuit of a single system compatible with the conventional NTSC receivers now in use results not only in lower picture quality improvement, but also increases the complexity of the transmission system and the receiver, not to mention increasing significantly its cost. In addition, luminance and color separation of the NTSC system is fundamentally flawed, limiting picture quality improvement in all ATV systems maintaining compatibility with the NTSC format. Figure 2 demonstrates the differences in picture quality delivered by each format. Table 1 describes these format differences. Thus, picture quality improve-



Table 1

ATV TECHNICAL COMPARISON

Format

MUSE:	Developed by NHK for use with satellite transmission. Compresses the base-bandwidth to 8.1 MHz using multiple sub-sampling. This is transmitted on a 9 MHz contiguous channel using VSB-AM. Incompatible with the NTSC format.
NARROW-MUSE:	A reduced version of the MUSE format using identical bandwidth compression algorithms. Base-bandwidth is compressed to 5 MHz. Incompatible with the NTSC format.
NTSC MUSE-6:	Maintains compatibility with the NTSC format. Picture quality improvement is done using the 6 MHz transmission bandwidth, and the high-resolution data is inserted into the 4.2 MHz base-bandwidth using the same MUSE compression techniques.
NTSC MUSE-9:	Maintains compatibility with both the NTSC and NTSC MUSE-6 formats. Additional data for improving picture quality is transmitted on an extra 3 MHz bandwidth. The MUSE bandwidth compression technique is used in the transmission of the additional data.

ment will always be greatest in systems relinquishing NTSC compatibility.

Limiting the frequency bandwidth to within 6 MHz while maintaining compatibility with the existing television system will mean that picture quality will have to be sacrificed to some extent. Efforts to raise picture quality at all costs will result in both an increase in interference with the conventional system when the increased amount of information is handled in addition to the degradation of compatibility.

#### C. SPECTRUM ISSUES CAN BE RESOLVED THROUGH RESEARCH AND PLANNING

In the U.S., the existence of open spectrum both above and below 1 GHz makes it possible to assign spectrum for terrestrial HDTV use. This, of course, requires coordination with other industries. It is clear that the spectrum use research by the FCC Advanced Television Advisory Committee is vital. Such research must cover a variety of scenarios and be conducted as soon as possible. For technical and economic reasons, 9 MHz channels are preferred. Non-contiguous channels would necessitate multiple demodulators, resulting in lower picture quality (ghosting) because of the difference in the transmission and reception characteristics between

the two channels, and in higher transmission and receiver costs.

It should be emphasized that any use of 6 MHz transmission bandwidth places restrictions on picture quality improvement, and there is little expectation for development of bandwidth compression technology to use less than 6 MHz in the foreseeable future. Expansion of the current bandwidth (6 MHz) by a minimum 3 MHz is thus considered best to implement high quality ATV.

NHK agrees with NTIA and NAB that appropriate testing of the UHF taboos and of proposed systems should be undertaken immediately and a timetable for such testing should be set forth as soon as possible so that a predictable schedule can be followed. NTIA, p. 8. NAB, p. 10-11.

**D. NHK PROPOSES COOPERATION TO MAKE THE MUSE FAMILY SYSTEMS READILY AVAILABLE**

NHK has spent 17 years developing an HDTV system. The hardware will be available to the public quickly, and with proper advance planning the broadcasting industry and the FCC can make the transition smoothly and with minimal cost. It is NHK's intention and desire to maintain a cooperative relationship that will be mutually beneficial to both the U.S. and Japan.

As has already been well documented, the inception of HDTV will mean greater interchange between television and other media (cinema, printing, etc.), opening up a dramatic new world for TV. Consequently, the introduction of HDTV should not be considered merely from a narrow viewpoint of technology or hardware, but should also be thought of, for example, in terms of what it will mean for expansion of America's preeminence in software. NHK has regarded the international integration and coordination of software and hardware as an important goal which can be of mutual benefit.

NHK, of course, has every intention of cooperating fully in the technical fields as well, and will make every effort in being fair in making any patents available to manufacturers both at home and abroad. Acceptance of readily available MUSE should be the goal and the least disruptive way to achieve it should be found.

E. TIME IS SHORT - ADOPTION OF MUSE WOULD DIMINISH ANY TIME ADVANTAGES OF BROADCASTING'S COMPETITORS

Several commentators expressed concern that unless the FCC moved quickly in adopting a transmission standard, other media would establish an advantage by developing their own capabilities to distribute HDTV programming.

CBS: Inaction or excessive regulatory delay...will necessarily relegate local broadcast stations to second class technical status...[N]othing less than a true HDTV transmission standard should be adopted. p. 2,3.

American Family Broadcast Group, Inc.: "Steps must be taken immediately to ensure that over-the-air delivery of a substantially enhanced 6 MHz TV signal compatible with existing receivers will be possible by the close of this decade.... [To make the N.A. Phillips and N.Y.I.T. systems] feasible will take much longer than the two or three year period left to broadcasters before MUSE [is present in the U.S.]." p. 2,5.

1. Production Standard

The 1125/60 production standard was recently adopted by the Advanced Television Systems Committee (ATSC). Production equipment in the 1125/60 format already exists and there is every likelihood that this production technique will be adopted quickly because of significant cost advantages over film and the fact that it is easier to use.

HDTV production equipment is now available in the U.S., Europe and Japan. Programs have also begun to be produced using this format, making compatibility an important consideration and goal for future programming. This standard was established with a view toward worldwide use in the future. Acceptance of the HDTV production standard and the resulting increased use of HDTV in productions means that software will be available for programming full HDTV. It also offers broadcasters the opportunity to replace depreciated NTSC production equipment with HDTV equipment in the normal course of business, ensuring a gradual transition to HDTV with a minimal incremental cost.

## 2. HDTV VCR and Laser Video Disc Development

Broadcasters have noted that development of consumer HDTV equipment will yield a MUSE-format VCR for use in the home by the early 1990's.

A number of consumer electronics companies already have produced prototype home-use MUSE VCRs using the half-inch cassette format, and such machines should hit the market at the same time as MUSE receivers.

HDTV can also be seen on laser video disc using the same MUSE receiver. Twelve inch compact disc videos (CDV) and players using NTSC were introduced on the mar-

ket last year and HDTV versions could be offered to coincide with the 1990 introduction of the MUSE receiver.

### 3. Cable Television

In all probability, HDTV service using the MUSE system will begin on cable television before being offered through terrestrial broadcasts.

Transmission using the current cable system can be provided both economically and with a minimum of network modification by employing the MUSE VSB-AM transmission format (9 MHz transmission bandwidth). It enables two channels of HDTV service to be provided on three of the conventional NTSC slots. The commencement of such transmissions, particularly the premium movie and sports services, is certain to make cable an even more attractive medium.

### 4. Direct Broadcast Satellites

Direct satellite to home broadcasting has been tested successfully in Japan and has begun service. The introduction of DBS in the United States has awaited a differentiation of its service from that of terrestrial broadcasting and cable television. HDTV provides that difference dramatically. DBS offers the opportunity for pay cable services and television networks to reach con-

sumers with an HDTV quality picture, prior to introduction of ATV by terrestrial broadcasters.

**F. THE COSTS OF A TWO PHASE TRANSITION TO MUSE HDTV WILL BE SIGNIFICANTLY DECREASED FOR BOTH CONSUMERS AND BROADCASTERS**

Broadcasters should remain competitive with other non-broadcast media by offering MUSE service in their communities. Transition from NTSC to MUSE should be planned now, while spectrum is available, so that the costs and difficulties of a gradual migration can be minimized. This ensures that broadcasters later will not find themselves shackled to an inferior system and be unable to find adequate spectrum to compete. The public interest in preserving competitive broadcasting in the local community requires that every effort be made to assist the migration. Without such a transition, consumer demand may force network entertainment and news programs to MUSE transmission through a combination of satellite-to-home and cable, thus by-passing NTSC affiliates.

Every effort must be made to minimize the economic and social impact of these changes on broadcasters. By recognizing the impact of superior MUSE signals in the marketplace and by planning a smooth transition, the



Commission may meet this challenge. Excessive attention to short run costs may doom broadcasters to a secondary role in video program delivery.

Data on the number of television sets sold in the U.S. suggests that if an HDTV standard were adopted quickly which allowed manufacturers to immediately begin building NTSC sets which include the MUSE and NTSC converter, the price of such a compatible set would increase only marginally, due to the tremendous volume of sets sold annually.\* Moreover, a date certain for a mandatory requirement that all NTSC sets sold have built-in converters would both facilitate the transition and significantly lower the cost of converters.

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\* Television Digest reports the following television sales:

Color TV	1985	16,995,667
	1986	18,204,156
	1987	-
Black & White TV	1985	3,753,860
	1986	3,958,925
	1987	-